

WHAT IS CLAIMED IS:

1        1. A micro-electro-mechanical device, characterized by a body of  
2 semiconductor material having a thickness and defining a mobile part and a fixed  
3 part,

4            said mobile part comprising a mobile platform, supporting arms extending  
5 from said mobile platform to said fixed part, and mobile electrodes fixed to said  
6 mobile platform;

7            said fixed part comprising fixed electrodes facing said mobile electrodes, a  
8 first biasing region fixed to said fixed electrodes, a second biasing region fixed to  
9 said supporting arms, and an insulation region of insulating material extending  
10 through the entire thickness of said body,

11            wherein said insulation region electrically insulates at least one between said  
12 first and second biasing regions from the rest of said fixed part.

1        2. The device according to claim 1, wherein said fixed electrodes extend  
2 from said first biasing region, and said supporting arms extend as a continuation of  
3 said second biasing region.

1        3. The device according to claim 1, wherein at least one through trench  
2 extends through the entire thickness of said body between said mobile part and said  
3 fixed part, and said at least one between said first and second biasing regions is  
4 further delimited by said through trench.

1        4. The device according to claim 3, wherein said insulation region has an  
2 arched shape with ends terminating on said through trench.

1        5. The device according to claim 3, wherein said insulating region  
2 comprises at least one first and one second insulating portion and a connecting  
3 portion, said first and second insulating portions having an arched shape with at  
4 least one respective end terminating on said through trench, and said connecting  
5 portion extends laterally with respect to said through trench between said insulating  
6 portions.

1        6. The device according to claim 3, wherein said insulation region  
2 surrounds said second biasing region.

1       7.    The device according to claim 1, wherein said body is of  
2    monocrystalline silicon.

1       8.    The device according to claim 1, constituting a micro-actuator for hard-  
2    disk drives.

1       9.    The device according to claim 1, wherein contact pads are formed  
2    above said mobile platform, and electrical-connection lines extend from said pads on  
3    said supporting arms.

1       10.   A process for manufacturing a micro-electro-mechanical device,  
2    comprising the steps of:

3           forming a body of semiconductor material having a thickness;  
4           forming, in said body, a mobile part and a fixed part,  
5           said mobile part comprising a platform, supporting arms extending from said  
6    mobile platform to said fixed part, and mobile electrodes fixed to said platform;  
7           said fixed part comprising fixed electrodes facing said mobile electrodes, at  
8    least one first biasing region fixed to said fixed electrodes, and one second biasing  
9    region fixed to said supporting arms, and  
10          forming, in said body, an insulating region of insulating material extending  
11    through the entire thickness of said body,

12          wherein said insulating region is shaped so as to insulate electrically at least  
13    one between said first and second biasing regions from the rest of said fixed part.

1       11.    The process according to claim 10, wherein said step of forming a body  
2    comprises providing a substrate of semiconductor material having a thickness  
3    greater than said body and thinning out said substrate from the rear, and said step of  
4    forming an insulating region comprises, before thinning out said substrate, forming  
5    an insulating structure in said substrate extending from a first surface of said  
6    substrate down to a depth equal to at least the thickness of said body so that, during  
7    said step of thinning out, said insulating structure is reached from behind.

1       12.    The process according to claim 11, wherein said step of forming an  
2    insulating structure comprises the steps of:

3           making insulating trenches in said substrate; and  
4           filling, at least partially, said insulating trenches with said insulating material.

1           13. The process according to claim 11, wherein, before said step of  
2 thinning out said substrate, the step of bonding said substrate to a supporting wafer  
3 is performed.

1           14. The process according to claim 13, comprising, before said step of  
2 bonding, the steps of:

3           forming electrical-connection structures above said first surface;  
4           forming bonding regions; and  
5           turning said substrate upside down with said first surface facing said  
6 supporting wafer, and

7           after said step of thinning out said substrate, the steps of:  
8           defining said fixed and mobile parts;  
9           dicing said substrate and removing said supporting wafer.

1           15. The process according to claim 13, wherein said step of bonding  
2 comprises turning said substrate upside down with said first surface facing said  
3 supporting wafer,

4           said step of thinning out said substrate comprises forming a second surface  
5 opposite to said first surface,

6           after said step of thinning out said substrate, the step of forming electrical-  
7 connection structures above said second surface is performed, and

8           after said step of thinning out said substrate, the steps of defining said fixed  
9 and mobile parts, thinning out said supporting wafer and dicing said substrate are  
10 performed.

1           16. The process according to claim 10, further comprising the step of  
2 bonding to said mobile part a slider for the reading/writing of hard disks.

1           17. A micro-electro-mechanical device, comprising:

2           a moveable portion comprising,

3           a moveable platform, and

4           a moveable electrode attached to the moveable platform;

5           a fixed portion having a fixed position relative to the moveable portion  
6 comprising,

7           a first biasing region,

8                   a fixed electrode attached to the first biasing region and facing the  
9                   moveable electrode,  
10                   a second biasing region, and  
11                   a region of insulating material extending through the fixed portion to  
12                   electrically insulate the first biasing region from the second biasing region; and  
13                   support arms that attach the moveable portion to the fixed portion.

1       18. The device of claim 17, further comprising:  
2                   multiple moveable electrodes attached to the moveable platform; and  
3                   multiple fixed electrodes attached to the first biasing region.

1       19. The device of claim 17, further comprising:  
2                   multiple first biasing regions; and  
3                   multiple fixed electrodes attached to each biasing portion.

1       20. The device of claim 17 wherein:  
2                   the moveable platform is substantially circular, and  
3                   the moveable electrodes extend radially.

1       21. A disk drive, comprising:  
2                   a disk operable to store data; and  
3                   a read/write-head assembly comprising,  
4                    a micro-electro-mechanical device, comprising:  
5                      a moveable portion comprising,  
6                      a moveable platform, and  
7                      a moveable electrode attached to the moveable platform;  
8                    a fixed portion having a fixed portion relative to the moveable  
9                   portion comprising,  
10                      a first biasing region,  
11                      a fixed electrode attached to the first biasing region and  
12                      facing the moveable electrode,  
13                      a second biasing region, and  
14                      a region of insulating material extending through the fixed  
15                      portion to electrically insulate the first biasing region from the second  
16                      biasing region; and

17 support arms that attach the moveable portion to the fixed portion; and  
18 a read/write head attached to the moveable platform.

1 22. An electronic system, comprising:  
2 a disk drive, comprising,  
3 a disk operable to store data, and  
4 a micro-electro-mechanical device, comprising:  
5 a moveable portion comprising,  
6 a moveable platform, and  
7 a moveable electrode attached to the moveable platform;  
8 a fixed portion having a fixed portion relative to the moveable  
9 portion comprising,  
10 a first biasing region,  
11 a fixed electrode attached to the first biasing region and  
12 facing the moveable electrode,  
13 a second biasing region, and  
14 a region of insulating material extending through the fixed  
15 portion to electrically insulate the first biasing region from the  
16 second biasing region; and  
17 support arms that attach the moveable portion to the fixed portion.

1 23. A method for manufacturing of a micro-actuator, comprising:  
2 forming first trenches in a first wafer;  
3 filling the first trenches with insulating material;  
4 attaching a second wafer to a first side of the first wafer for support during  
5 manufacturing;  
6 exposing the trenches through a second side of the first wafer to form a first  
7 biasing region and a second biasing region separated by the insulating material; and  
8 forming second trenches in the first wafer to define fixed electrodes that are  
9 integral with the first biasing region and moveable electrodes adjacent to the fixed  
10 electrodes and elastically coupled to the second biasing region.

1 24. The method of claim 23, further comprising:  
2 coating the first side of the first wafer with an insulating layer; and  
3 forming contact openings in the insulating layer.

1        25. The method of claim 24, further comprising:  
2           forming electrical-connection structures on the insulating layer; and  
3           forming contact pads in the contact openings.

1        26. The method of claim 23 wherein forming the second trenches  
2           comprises forming the second trenches such that the fixed electrodes and the  
3           moveable electrodes are intertwined.

1        27. The method of claim 25, further comprising removing the second wafer  
2           from the first wafer.

1        28. The method of claim 25, further comprising:  
2           forming a platform that is attached to the moveable electrodes; and  
3           attaching a read/write head to the platform.

1        29. A method for the manufacture of a magnetic hard disk micro-actuator,  
2           comprising:

3           forming first trenches in a first side of a first wafer;  
4           filling the first trenches with insulating material;  
5           attaching a second wafer to the first side of the first wafer to provide a  
6           substrate;  
7           exposing the trenches through a second side of the first wafer to form a first  
8           biasing region and a second biasing region separated by the insulating material;

9           forming second trenches in the first wafer to define fixed electrodes that are  
10          integral with the first biasing region and moveable electrodes adjacent to the fixed  
11          electrodes and elastically coupled to the second biasing region.

1        30. The method of claim 29, further comprising:  
2           coating the second side of the first wafer with an insulating layer; and  
3           forming contact openings in the insulating layer.

1        31. The method of claim 30, further comprising:  
2           forming electrical-connection structures on the insulating layer; and  
3           forming contact pads in the contact openings.

1        32. The method of claim 29, further comprising cutting the first wafer into  
2           dies to form fixed electrodes extending from the first biasing region towards a  
3           platform wherein the fixed electrodes and the moveable electrodes are intertwined.

1       33. The method of claim 29, further comprising thinning the second wafer.

1       34. The method of claim 33 wherein thinning the second wafer further  
2   comprises mechanically grinding the second wafer to a thickness of approximately  
3   100 micrometers.

1       35. The method of claim 29 wherein forming first trenches comprises  
2   forming the first trenches in U-shapes.

1       36. The method of claim 29 wherein attaching a second wafer to the first  
2   side of the first wafer further comprises a low temperature thermal treating wherein  
3   connecting regions react with the first wafer.

1       37. The method of claim 36 wherein:  
2       the connecting regions further comprise gold, and  
3       the treating further comprises forming a gold/silicon eutectic.

1       38. The method of claim 36 wherein:  
2       the connecting regions further comprise palladium, and  
3       the treating further comprises forming a silicide.

1       39. The method of claim 33 wherein the fixed electrodes are further than  
2   substantially 2 micrometers from the moveable electrodes.